BOTANICAL GAZETTE

SEPTEMBER, 1894.

The evolution of the Hepaticæ.

Vice-presidential address before section G, A. A. A. S.

LUCIEN M. UNDERWOOD.

There is, perhaps, a natural tendency among specialists to magnify the importance of the particular subject or group of life forms in which they happen to be specially interested. The horticultural botanist, dreaming of the time when the world will be reorganized through the products of his art, is prone to see nothing beyond utility and ornament in plants, and it becomes a part of his nature to see some useful character in forms of vegetation which to others are devoid of either beauty or utility. The economic mycologist, over-impressed with the magnitude of the losses sustained by the unfortunate agriculturist and fruit grower, is haunted in sleep with visions of anthracnose and mildew, and in his waking hours sees little in botany but host-plants bristling with parasites and Bordeaux mixtures certain to relieve them of their incubus. The man with inherent, if not coherent, proclivities for priority, with a war-like temperament and a strong tendency to cross lances, sees in botany one vast battle field of synonymy in which cohorts of pre-Linnaean binomials, hordes of decapitalization dogmas, hostile homonyms and Kuntzian curiosities charge down upon each other in battalions, form and *reform* in utter confusion. There are some microscopic botanists whose degree of specialization never permits them to look outside the limits of an apical cell; and others still whose botanical horizon is bounded by the field of an immersion lens and whose azimuth and right ascension are calculated within its limits. We are all more or less inclined to ride our own hobbies in public places, so in performing the initial function of this office, I can perhaps do no better than to bring forth mine. In this way, I shall at least be in touch with present custom.

With no desire, however, to overestimate its importance, I wish to place before you the position in the botanical system of a comparatively obscure group of plants and to call your attention for a brief time no less to their own differentiation than to their important relation to the evolution of the plant world. I desire to set forth in something of a reasonable way the characters of the group and to correct some misunderstandings that have resulted from an imperfect appreciation of its relations. The group commonly known as Hepaticæ has suffered at the hands of general botanists, and through them an incomplete and one-sided conception is transmitted to the generation of botanical students now coming to their maturity. The average text-book of botany emphasizes strongly the representative character of Marchantia polymorpha. In elementary laboratory guides, this is even made to stand as the sole representative of all the bryophytes. In those somewhat more comprehensive, it is made a type of the more limited group, the Hepaticæ, and in even the most complete it is made to stand pre-eminent as the representative of this triply developed group of plants, notwithstanding the fact that the other members of this trio are vastly more important—one in the nature and extent of its development *per se*, and the other in its important relations to the development of the higher groups of the plant world. One elementary text-book that has in general done much to elevate the standard of botanical teaching in America during the past decade opens its account of the Hepaticæ with these words: "In the liverworts the plant body is for the most part either a true thallus or a thalloid structure. When there is a differentiation into stem and leaves," etc. This statement may be taken as fairly representing a conception of the group common among botanists and botanical teachers. The hepatics among us are popularly supposed to be thallose or thalloid plants and Marchantia is regarded as a normal representative. As opposed to this wide-spread misconception, it should be noted that as far back as the date of the last publication of a general synopsis of the Hepaticæ (1847) the relative numerical importance of the Marchantiaceæ was only 17 per cent. of the entire group and the increase since that time has been even more largely in the direction of the other groups, especially the foliaceous Jungermaniaceæ which represent at once the most numerous and best differentiated

types of the Hepaticæ.[1] It would be even less a misrepresentation of the Musci to make its representatives in Andreaea, Phascum or Buxbaumia than to place Marchantia or any of its allies as a normal representative of the Hepaticæ. Armed, however, with such a conception gained from the elementary texts and emphasized by the works of reference usually accessible in an ordinary laboratory, as for example Kny, Strasburger, Sachs, and Goebel, the student goes forth into the field to study liverworts and after he has exhausted Marchantia and Conocephalus, and has possibly seen a Riccia, he is usually stranded and knows not what to seek. In fact, many are more likely to confuse some such thallose lichen, as Peltigera, with liverworts than to look for them among leafy forms which their training has not rendered them able to properly correlate. The Lophocoleas, the Cephalozias, the Frullanias and the Radulas, so elegant in their structure as to impress the least æsthetic student with their beauty, so diversified in their evolution as to demand the exercise of his most active powers of reflection, and withal so simple in structure as to render them accessible with a minimum of microscopic technique—these are a closed volume to him because of the limitations of his early instruction and impressions.

The group known since the time of Adanson as the Hepaticæ stands in a unique position on the boundary line of thallose and leafy plants, and its position is not only intermediate from the structural standpoint, but in its relation to the evolution of the higher plants it stands as a key or link between the lower and simpler and the higher and more complex. The group is not a compact one nor are its component groups closely united to each other. It is even to be doubted if a good reason exists for the separation of the bryophytes into the two classes Musci and Hepaticæ, and it would be hazardous to attempt their separation as coordinate groups on any rational grounds, even if we leave in question their relation to the Sphagnaceæ.

[1] The relative extent of the Jungermaniaceæ as developed by modern exploration and subsequent study can be seen in a comparison of a few representative genera:

	Species described in Synopsis Hepaticarum 1844–47.	Species reported by Schiffner 1893.
Metzgeria	8	36
Lophocolea	69	149
Plagiochila	179	463

The hepatics possess almost absolutely no utilitarian aspect. Beyond the doubtful use of one or two in medicine, and the occasional occurrence of one or more tropical species as weeds, they are, so far as the physical condition of the human race is concerned, an entirely useless group of plants. They do not trouble the experiment station botanist, the horticulturist finds no use for them, and the general public does not see sufficient importance in them to subscribe a single shilling for the endowment of a laboratory for research in such an apparently barren field. And yet from the higher standpoint of genetic relationship, there is probably no single group of plants that occupies such an unique position in the plant world. What the comprehensive and heterogeneous group "Vermes" is to the animal kingdom, the Hepaticæ are to plants, with this difference, that we have here a much less complicated group of organisms with which to deal.

To understand more fully the relation of the Hepaticæ to the evolution of the green plants and particularly to their role in the development of the alternation of phases of reproduction which has attained such extended proportions in the ferns and other pteridophytes, it is desirable to bring in brief review the successive stages in the processes of reproduction from the simplest forms upward. For it must be remembered that even if the methods of reproduction cannot serve as the means of separating the primary types of the thallophytes in a natural system of classification, they nevertheless represent the highest function that is manifested in organic life. The successive stages may be characterized as follows:

I. Among forms whose only method of reproduction consists of fission, in which the individual life begins with the completion of the karyokinetic process of cell division and closes when its individuality is lost in the next generation produced, the type of the life history of the organism may be represented by a straight line whose terminations bear no relation to each other. There is no round of life history, no cycle of development where fission is the law of reproduction.

II. Among forms in which conjugation occurs, we have successive stages of distinct sexual reproduction occurring before the idea of bisexuality has been differentiated. Two purposes seem involved in this process, (1) the increase of vitality by the union of elements of separate origin, and (2) the production of a structure capable of holding vitality more

certainly through critical changes of environment; hence the resting-spore. We have here a type of life history where continuity commences to curve into a circle and its ends begin to unite to form a complete cycle of development. In many forms, however, the individual is too hopelessly entangled in colony life to be clearly separated.

III. In forms (like Vaucheria) where the sexual cells are clearly distinguishable from the early commencement of the process of reproduction, and the oospore results directly and simply from the act of fertilization, the life history of the plant may be clearly said to be represented by the circle. The phase of growth is purely a sexual one from spore to germinating filament through the production of sexual apparatus to spore again. If asexual reproduction occurs, it merely serves to rapidly multiply the plant when favoring environment makes it possible, and bears no relation to the sexual process and is not dependent upon it.

IV. Among some of the higher algæ occurs the simplest form of alternation of phases of reproduction. While there are various modifications of the process in minor details in many groups of algæ, the act of fertilization in certain representative forms is followed (1) by the formation of a special envelop of cells about the oogone as a specialized protective covering, and (2) by the division of the cell contents of the oogone into a series of reproductive bodies, an asexual process following as a result of a sexual one and therefore dependent on it. The life history here, instead of representing a simple cycle of growth, can be best characterized as a combination of two loops each short of a circle, the larger representing the sexual stage from germinating spore to the completion of the process of fertilization, and the smaller representing the asexual phase involved in the internal cell division that results in the development of the reproductive bodies. The so-called "alternation of generations", which is nothing more than the succession of phases in the life history of the organism, commences at a point considerably below the lowest bryophytes.

V. The transition from the above condition to that which we find in the lowest archegoniates is a simple one. The advance manifests itself in the following particulars: (1) in the protective envelop of the egg cell being developed prior to the act of fertilization and not as a result of it; (2) in the some-

what more complex development of the asexual phase (sporogone) in the formation of a definite multicellular wall and the division of the interior by a double process of cell multiplication. Most of these details even are more or less feebly foreshadowed in some of the higher algæ. The only modification necessary in the diagrammatic representation of the lower bryophytes as contrasted with that of the higher algæ is the relatively greater development of the asexual phase which is therefore represented by a proportionally larger loop. The lines of specialization which have resulted from the varied differentiations of this simple type will be discussed more in detail later in this paper.

VI. The highest development of the principle of alternation of phases of reproduction is illustrated by the well known climax reached among the pteridophytes in which the asexual phase represents a degree of specialization utterly disproportionate to the simple sexual phase (prothallus) which has scarcely advanced beyond the primitive condition reached by the lowest archegoniates. The diagrammatic representation of the life history of the fern is therefore a reversal of that of the higher algæ, the larger loop representing the highly differentiated asexual phase and the smaller the simple thallose sexual phase.

The high degree of differentiation of the asexual phase of the pteridophytes coupled with the great antiquity of the group have rendered them a stumbling block to many who have not been careful in tracing their homologies. In the evolution of the pteridophytes, however it must be remembered that the line of descent must be sought, not in a comparison of the highly developed asexual phase of the one with the simple sporogone of the other but along the line of the simpler sexual phase. When we consider this feature of the development in its proper light, the progress of evolution from alga to fern is greatly simplified and the distance between the groups either in the time necessary for the derivation of the one from the other or in the slight degree of differentiation manifest in these coordinate phases, is reduced to a minimum. From higher algæ to simple prothallus the transition is not a difficult one. In regard to the other feature of the problem, it may be suggested that the development of the asexual phase of fern-like plants which dates back to the Devonian and reached a high degree of specialization in the Carboniferous,

may have been strongly influenced and perhaps rapidly evolved by the peculiar environment of precarboniferous times; at least the statements of the books in reference to the excessive amount of carbonic oxide in the atmosphere being peculiarly adapted to the growth and development of the lower pteridophytes would support such a hypothesis. On this point, however, it may be questioned whether the statements of the books do not need some modification.

I have said that the Hepaticæ have undergone a triple differentiation. Commencing with a simple thallose plant with its unmodified sporogone, it is evident that there are three possible lines of specialization: (1) the development of the thallus as such; (2) the transformation of the thallus into a leafy axis combined with the modification from creeping to ascending or erect habit; and (3) the specialization of the sporogone at the expense of the thallus. Even a cursory acquaintance with the diverse structures that are developed in the group will make it evident that the Hepaticæ have improved their opportunity in each of these three possible lines and have carried the differentiation of each line to a high degree of perfection. Let us follow out in some detail these three lines of development.

I. *The Marchantiales.* We must place as lowest in the series the group which commences with such simple types as Riccia and Tesselina and ends with the elaborate Marchantia and its congeners. Among the lowest types the habit is not greatly different from that of the algæ, the plants either floating in water or attaching themselves to wet soil. The capsular development in the lower forms moreover is not very diverse from that of certain of the higher algæ, the sporogone being without stem and often imperfectly surrounded by a capsular wall. As we advance to higher forms, we find not only an extensive modification of the thalloid structure necessitating an elaborate system of stomata and in many cases specially modified branches for the better accommodation of the reproductive bodies, but also a striking advance in the capsular development in which the egg cell develops not only a capsule or fertile portion, but also a stalk or sterile portion, which with the addition of elaters formed within the capsule, better serves to distribute the spores.

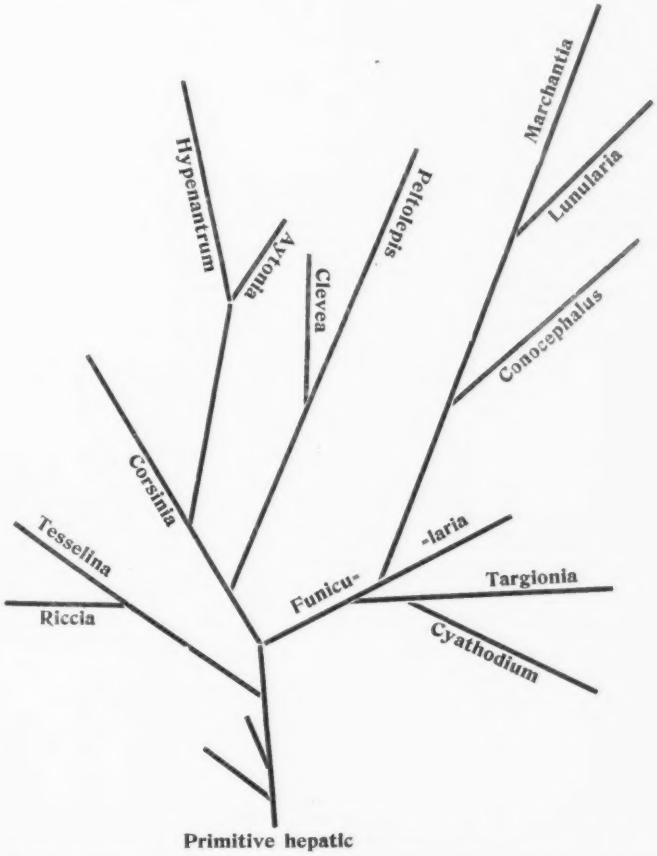
We may note here also two types of differentiation in the specialized branch that bears the carpocephalum, as it ex-

plains some seeming anomalies in the fruiting habits of some of our common Marchantiaceæ. The impression has prevailed and is now wide spread that while Marchantia may commonly be found in fruit, Conocephalus rarely produces it. The fruiting branch of Marchantia is developed before the maturity of the sporogone is reached. This branch is therefore firm and consequently persistent. The botanist who only rarely comes in contact with plants except as they are preserved in herbaria or imbedded in celloidin has considerable opportunity to see the fruit bearing branches of Marchantia as they are developed, long before the spores are mature and persist long after the spores are scattered. On the other hand, Conocephalus, whose archegones are fertilized during the late summer or early autumn, matures its capsules within the carpocephalum before the fruit bearing branch of the thallus is developed. In this condition it passes the winter and with the earliest return of spring the reserve material of the thallus rapidly aids in sending up a semi-hyaline slender branch which lasts barely long enough to allow the capsules to burst through their calyptræ and then withers away. By the time the spring botanist, roused from his hibernation, goes forth to search for Anemone or Epigæa, Conocephalus has long since scattered its spores, its fruiting branch is withered, and the late observer concludes that it rarely produces fruit. He who will become a botanist in any broad sense must come in contact with nature face to face at all seasons, and study plants as they grow, as well as in the herbarium and laboratory. The man who sees and studies plants *only* as they are represented by dried herbarium fragments or in accordance with the stereotyped formula, "treated with a one per cent. solution of chromic acid, stained in mass with picrocarmine, imbedded in paraffine and cut with a Minot microtome," is sure to get a one-sided notion of the true homologies of the vegetable world.

While all the minutiæ of the relations of the Marchantiales have not been worked out, the following provisional arrangement (see diagram opposite) will give some idea of their affinities.

From simple forms like Riccia, themselves doubtless a considerable advance over the primitive hepatic, we find slight modification in Ricciocarpus and Tesselina, and slightly more differentiated forms in Corsinia and Funicularia. To the former are allied such higher forms as Clevea, Aytonia and

Hypenantrum; from forms allied to the latter we have on the one hand Cyathodium and Targionia with their sessile fruit, and on the other, Lunularia, Conocephalus and Marchantia,



which justly may be regarded as the highest thalloid development that appears among the Hepaticæ.

II. *The Jungermaniales.* The second line of differentiation among the Hepaticæ is in the direction of the formation of a leafy axis. From such thalloid forms as Aneura with a

scarcely developed central axis to such simple modifications as appear in Pallavicinia and Metzgeria, in which the central axis becomes distinctly differentiated from the plain wing-like border a single cell in thickness, it is an easy step to pass to such pseudofoliaceous forms as Schiffneria, Fossombronia and Haplomitrium. From these forms again it is not difficult to pass to some of the simpler leafy axes like Lophocolea, Bazzania, and Jungermania. It is in this group that we find the Hepaticæ attaining their greatest profusion of structure, the most remarkable diversity of foliar development, the widest range of adaptation, and the consequent abundance of genera and species that span the world from the lone and barren island of Kerguelen in the south to the inhospitable region of Spitzbergen in the north. Here some three thousand species have been developed, and judging from the rapidity of the returns, it is evident that the tale is not nearly told.

It is, of course, impossible, within the limits of the time assigned, to attempt to touch upon the numerous features of the evolution which this group has undergone in diverse quarters of the world; we can only hint at some of the more striking by way of illustration.

1. The protonemal development among the Jungermaniales is usually slight and ephemeral; in only occasional instances do we find it persistent. Perhaps the most striking illustration of this is Protocephalozia, in which the formation of leaves occurs only as a special development for the protection of the reproductive bodies. The antherids are borne singly in the axils of rudimentary leaves while the perianth, subtended by slender involucral leaves, rises directly from the original protonema which represents the entire vegetative condition of the plant.

2. The lines of development leading from thallose to leafy forms are numerous among the Jungermaniales, and all of them have not yet been definitely correlated. Certain it is that there is no single line of thallose genera as distinct from the foliaceous ones. While the greater part of the thallose forms do not produce their fruit terminally and hence may be separated into a distinct family which may be called the *Metzgeriaceæ* from its typical genus, there are several instances in which thallose forms lead up toward foliaceous forms with which they agree in the closer relation of sporogonial development, as well as in the more important fact that they bear

the sporogone terminal on the main stem or on a branch. The line of this character that is best known is perhaps that leading up to the Trigonantheæ from Zoopsis to Cephalozia. From the simplest thallose structure, differing only slightly from algæ, the various species of Zoopsis become developed so as to present the successive modifications of a leaf of a single cell, a leaf of two cells, and a leaf of four cells; from these steps the passage is easy to such simple two-toothed decurrent leaves as we see developed in some of the Cephalozias, especially in our common Cephalozia multiflora. The fruiting characters in this series are so strikingly alike that they have even been united in a single genus.

3. Perhaps no single group presents so many modifications in the diversity of foliar structure as is manifested in the various genera of the Jungermaniales. With nothing but leaf cells forming a more or less well developed lamina, the greatest conceivable variety of form coupled with modification arising from environment has been differentiated, and we find numerous examples of marvellous adaptation of means to end. From these we may note the simple tripartite leaves of Blepharostoma made up of simple rows of cells; the intricately divided leaves of Trichocolea and Ptilidium which give to the species of those genera their peculiar tomentose appearance; the ciliary fringes of endless variety that characterize the numerous species of Plagiochila; the median lamina of Schistocheila recalling a similiar development in Fissidens among the true mosses, and above all the innumerable paraphyllia of Stephaniella, often covering the entire surface of the leaf. These merely indicate a few of the possibilities of the foliar development. In the leaf cells themselves, we have every grade of compactness, varying from the lax structure of Cephalozia, Chiloscyphus and Kantia to the close compact structure of Herberta and Gymnomitrium.

But beyond all these are the various forms of complication of leaves clearly adapted to serve as retainers of moisture. From the simple folds in the leaves of Radula, Scapania and Diplophyllum, we pass to the basal pockets of Lejeunea which are sometimes elaborately differentiated, and the water sacs of Jubula, Frullania and more especially Polyotus in which they are sometimes developed in great profusion. As might be expected, these peculiar foliar adaptations for holding moisture most prominent in those species that have been driven

from their normal habitat on the ground and on decaying logs to the bark of trees and even the surface of leaves, which in tropical countries are often wholly covered with various species of Lejeunea,[2] together with an occasional Radula and rarely species of other genera. The reputed symbiosis of rotifers and other small animals with these water sacs of Lejeunea and Frullania has been commented on by many observers.

4. No less remarkable is the development of the perianth which serves as a special protection to the maturing sporogone. This is normally free from the uppermost stem leaves, which are usually modified from the ordinary form. In certain genera like Nardia, Marsupella, Schistocheila and Harpanthus, the perianth becomes more or less adherent to the involucral leaves and in some instances forms a bulbous or gibbous enlargement at the base. An exaggeration of this bulbous development produces the marsupiocarpous condition found in Kantia, Geocalyx, Tylimanthus and several other genera, in which the sporogone is developed at the base of a pendulous pouch which penetrates the substratum, or in the tropical Tylimanthus is hung among the stems of various mosses which grow in its vicinity. It is of interest to note that this condition has been developed independently in widely different sections of the family and cannot be considered as forming a tribal alliance by itself as was formerly maintained.

It must now be evident that the Jungermaniales, above all other Hepaticæ, are the types in which the most elaborate development has taken place and that they must furnish the typical representatives of this class. When we add to the great degree of differentiation, the wide-spread geographic distribution of the Jungermaniales which has resulted in populating almost every available island in the world, frequently with endemic species, it becomes evident that we must attribute a great antiquity to the group. The comparative absence of the hepatics in fossiliferous rocks, for obvious reasons, should count as little in determining their antiquity.

III. *The Anthocerotales.* Having considered the two groups in which the hepatics have disported themselves as such, we

[2] I have only once found our Lejeunea calcarea in Indiana. In that instance, it completely covered a small leaf of Camptosorus growing in the damp moss of a ravine. This is the first instance known to me of Lejeunea growing as an epiphyte in northern latitudes.

come finally to the group in which their development has looked toward something higher in the plant world. If the Marchantiales have elaborated the thallus at the expense of other parts, and the Jungermaniales have developed leafy axes and exhausted their energies in the elaboration of beauty and intricacy of foliar development, the Anthocerotales have found a more important line in which to differentiate, namely, the development of the sporogone. And while it has resulted in small returns when considered from a hepatic standpoint, the results otherwise are commensurate with the whole range of higher plants from mosses to Compositæ.

In the Anthocerotales, the thallus has undergone only a slight differentiation from the primitive type; the sporogone, however, develops into a fleshy structure that frequently requires stomata for its transpiration processes. The capsule is necessarily a somewhat permanent structure and unlike all other bryophytes, develops its spores continuously from above downward.

The ancestors of Anthoceros and Notothylas on the one hand, and the Musci on the other, were doubtless the same, and the line of separation between them probably commenced at an early day, since the elaboration of genera and species is no less marked in the Musci than in the foliaceous Hepaticæ.

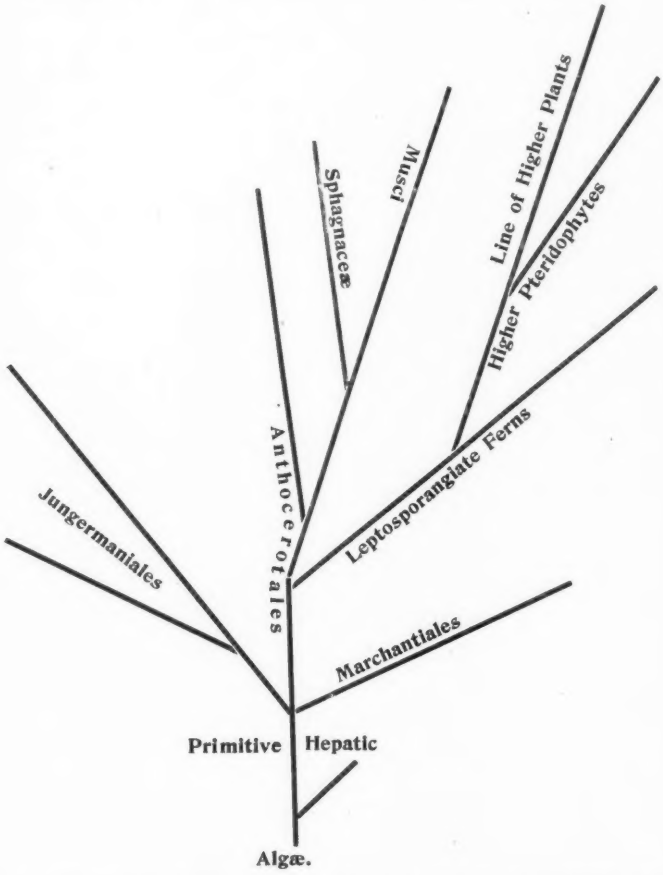
It has further become evident that the line of development of the leptosporangiate ferns, leading upward to the line of the higher plants, is to be sought as a branch from the primitive Anthocerotales. While more investigation is necessary in this direction, the general relations may be indicated by the diagram on the following page.

The early forms of Anthoceros were not swerved from their purpose; they have continued the development of the sporogone at the expense of the thallus and today stand unique among the Hepaticæ. They differ as widely from all other members of the group as do the Musci and Sphagnaceæ and, for this reason combined with others, the class Hepaticæ has little reason for further existence in our system of classification. A reorganization becomes necessary as soon as the remaining bryophytes can be properly co-ordinated.

We can then summarize the relations of the Hepaticæ.

1. The group is not of recent origin. This is shown not only from the wide-spread geographic distribution of its ma-

jor group, and its extensive modification into diverse genera, but as well by its relations through the Anthocerotales to higher groups which have themselves a high antiquity.



2. The group is not a compact one, nor is it entirely circumscribed. The three groups of the Hepaticæ above outlined differ as much or more among themselves as the remaining bryophytes differ from them. There is a necessity for a new grouping of the bryophytes to accord with our present

knowledge. The present grouping into Musci and Hepaticæ as coordinate classes, is entirely unsatisfactory, and artificial.

3. In such a triple development as exists among the Hepaticæ, no single plant can stand as a type which will fairly represent the entire group. If a single plant is to be considered, however, it would be only fair to make the selection from the group which is at once the most highly specialized structurally and the most widely represented in all parts of the world. To the Jungermaniales, and not to the Marchantiales, belongs this distinction.

4. We must recognize at least five families among the Hepaticæ. Among the Jungermaniaceæ, it is well to separate those forms in which the archegone terminates the growth of the shoot from those in which the archegone is distinctively a lateral development. The "Jungermaniaceæ anakrogynæ" of Leitgeb and Schiffner, which will include many but not all of the "Jungermaniaceæ thallosæ" of previous writers, may well be separated as a distinct family for which we propose the name METZGERIACEÆ. The older name, Jungermaniaceæ, may properly be retained for the remaining part of the family which includes by far the greater number of genera and species.

5. The Hepaticæ are especially interesting as constituting the connecting link in the evolution from thallophytes (algæ) to the higher plants. In this particular, the line of the Anthocerotales in which mere vegetative function is sacrificed for the sake of reproductive function, represents the royal line of development.

De Pauw University, Greencastle, Ind.

Proceedings of section G, A. A. A. S., Brooklyn meeting, 1894.

THURSDAY, AUGUST 16TH.

Section G met at 11:15 A. M., and organized by electing as councilor, Byron D. Halsted; as members of sectional committee, in addition to the ex officio members, Geo. F. Atkinson, W. J. Beal, B. T. Galloway; as member of nominating committee, A. B. Seymour; as committee to nominate officers of section, the officers and John M. Coulter, M. B. Waite, and J. J. Davis.

At the suggestion of the council a new officer, to prepare for the press readable reports of papers presented, was appointed. Byron D. Halsted was elected "press secretary."

At 4:30 P. M., vice-president Underwood's address (printed in full elsewhere) was read by Dr. S. E. Jeliffe.

MONDAY, AUGUST 20TH.

Reports from the standing committees appointed by the Madison Botanical Congress were called for.

The Committee on Bibliography and Typography presented the following report:

To section G, A. A. A. S.:

The Committee on Bibliography and Typography appointed by the Madison Botanical Congress was directed to report to section G of the American Association for the Advancement of Science. This section therefore is asked to receive the following report and take such action thereupon as seems wise:

The committee report that progress has been made during the past year in carrying out the suggestions made to the Madison Botanical Congress.[1] The first recommendation thereto made, viz., "that there should be published . . . a catalogue of papers [relating to American botany] by authors," has been undertaken and so far as it has gone has been successfully accomplished by the cooperation of a number of botanists with the editors of the *Bulletin* of the Torrey Botanical Club and the Cambridge Botanical Supply Co. This index, printed first in the *Bulletin*, is reprinted upon standard cards by the Cambridge Botanical Supply Co., so

[1] Proc. Madison Bot. Congress 45. Je 1894.

that any number of copies can be had and arranged by subjects or by journals as desired. Every effort will be made by those charged with the preparation of this index and its first publication to make it complete, and to have it conform exactly to the rules for citation prepared by this committee. The work of publication upon cards, however, is not adequately supported. The committee sincerely hope that this form of publication will not have to be given up, and they therefore urge that those interested testify their interest by sending their subscriptions to the Cambridge Botanical Supply Co., Cambridge, Mass.

The committee also announce that the BOTANICAL GAZETTE, in connection with the Cambridge Botanical Supply Co., is ready to undertake the publication of the supplementary list of journals referred to in section 1. *b.* of the committee's report[2] to the Congress which appointed it. The publication of these lists of journals upon cards will be begun as soon as subscribers sufficient to defray the expense of printing the cards can be secured. In the same way the *Bulletin* of the Torrey Botanical Club will undertake the publication of the list of authors referred to in the committee's report under 1. *c.* If the number of subscribers to the index of papers above mentioned as in course of publication can be immediately increased, these author and journal cards will, for the present year, be sent free to subscribers.

The committee again call attention to the index of new genera and species of plants now being issued on cards by Miss Josephine A. Clark, of Washington, D. C., and commend this to the support of botanists. Regarding this private publication they beg to suggest (1) that there be added to these cards such marks as will serve to identify the series when distributed in other indexes; (2) that in the interest of completeness *all* new names relating to North American plants be included.

A year's experience in the working of the rules for citation approved by the Madison Congress has not shown the necessity or desirability of any changes. To those rules, however, the committee desire to add the following amplification:

In *f*, p. 46, l. c., before the last sentence insert: In case the original paging is unknown an em dash should occupy

[2] Loc. cit.

its place, the reprint paging being given in accordance with the foregoing rule.

The committee also recommend the adoption of the two following paragraphs as addenda:

j. If it is considered desirable to give other data than series number (if any), volume number, page and date, these should be added in brackets after the date. But useless or unnecessary data should be avoided.

k. Citations of reviews, abstracts, and all such secondary references should be enclosed in parentheses.

Since uniformity is the chief object in the adoption of the rules for citation by the Congress, the committee call attention to the necessity of an exact following of these rules by as many writers and publishers as can be induced to give adhesion to them. To facilitate this we recommend that the editors of the *Bulletin* of the Torrey Botanical Club, the *Botanical Gazette*, *Erythea*, and the *American Naturalist* be requested to publish these rules, and examples of as great a variety of citations as practicable. The committee also desire to issue these on tag-board sheets, in a form which can be readily distributed and preserved for convenient reference. To enable the committee to do this, and to disseminate information upon these points, we recommend that the Council of the A. A. A. S. be requested to make a grant of $25 to cover the necessary expenses which may be incurred.

C. R. BARNES,
A. B. SEYMOUR,
L. L. BRITTON,
for the Committee.

The report was accepted and adopted, and the committee continued.

The grant asked for was voted by the Council of the A. A. A. S. at its meeting on Tuesday morning. The committee will therefore have printed shortly the rules for citations, with examples, in large type upon tag-board, and mail copies to all desiring them. Application should be made to the Cambridge Botanical Supply Co., Cambridge, Mass.

The Committee on the Terminology of Physiology was called. In the absence of the chairman, Dr. J. C. Arthur, Dr. Barnes reported that so far as he was aware, the committee had done nothing. The committee was continued with instructions by the Section to prosecute its work.

The Committee on the Terminology of Anatomy and Morphology was called. No report was ready. In the absence of the chairman, Prof. Conway MacMillan, it was suggested that the committee be continued with instructions to present a report next year, since suggestions by this committee are desired to secure as great uniformity as possible in the terminology of the new Systematic Botany of North America.

The Committee on Geographical Botany reported that its work was in progress and that a full report would be rendered next year. The committee recommended that two additional members, Dr. N. L. Britton, selected by the committee, and one to be named by the vice-president of the Section, be appointed. The report was accepted and adopted, and the committee continued.

The Committee on the Nomenclature of Plant Diseases was called. The chairman, Dr. B. D. Halsted, announced that a report would be ready on Tuesday.

In joint session of Sections F and G the following resolutions of the Committee of the A. A. A. S. on a table at the Marine Biological Laboratory at Woods Holl, Mass., were offered by Dr. S. H. Gage for adoption by the Sections:

The Sections of Zoology and Botany (F and G) request that the Association continue its subscription of $100 for an investigators' table at the Marine Biological Laboratory at Woods Holl, Mass.

The two sections in joint session also make the following suggestions for the award and government of the table subscribed for by the Association:

1. That the table shall be known as the A. A. A. S. table.

2. That the award of this table shall be entrusted to a committee of five, consisting of the vice-president and secretary elect of each Section (F and G), and of the director of the Marine Biological Laboratory (at present C. O. Whitman).

3. Any fellow or member of the A. A. A. S. shall be eligible for appointment to the table. (An applicant for membership in the Association will be considered as a member and therefore eligible.)

4. Applications for the table are to be made to the permanent secretary, who shall forward them to the senior vice-president of Sections F and G, seniority being determined as in §11 of the Constitution, i. e., according to continuous membership.

5. That the holders of the Association's table are expected to give proper credit for the use of the table in all published results of investigations carried on at the table.

The resolutions were adopted. At a meeting of the Council in the evening the subscription was continued for 1895 and the above regulations for its use adopted.

TUESDAY, AUGUST 21ST.

The Committee on the Nomenclature of Plant Diseases presented the following report, which was accepted and adopted, and the committee continued.

To Section G of the American Association for the Advancement of Science:

The Committee upon the Nomenclature of Plant Diseases, appointed by the Madison Botanical Congress, by vote of that body begs to make the following report:

The committee finds itself with a somewhat difficult task upon its hands. Names of fungous diseases that are now in general use it will be difficult, if not impossible, to uproot and set aside. Thus the black rot of the grape and black knot of plum and cherry are well known, distinctive and fixed. In an ideal nomenclatural system there would be distinctive common names for the various groups. This in a measure has been accomplished, for we have downy mildews for Peronosporeæ, rusts for Uredineæ, and smuts for Ustilagineæ. There is a vast number of species of the large genera like Septoria, Phyllosticta, Cercospora, Ramularia, etc., that are not easily given general names. Thus a Septoria or Phyllosticta may produce a definite spot upon the leaf or affect the whole area and the term "leaf spot" is inappropriate. It is possible, for example, for blights (pear), rots (hyacinth), wilts (melon), tuberculosis (olive), and other diseases to be produced by bacteria. It is suggested that when possible the term bacteriosis be used for such cases. This can be done when a mycologist has the opportunity to set forth the disease before the world, and antedate any name or names, for there may be many, that arise among the people.

Anthracnose is a name that is used so generally that it has very little significance. It should, like many others, be restricted.

Without further argument the principal points which the committee would respectfully present for your consideration are as follows:

(1) When a good name has become firmly established no effort should now be made to change it, except when it is manifestly inappropriate, as the so-called "strawberry rust" and "celery rust."

(2) There should be terms to distinguish between the parasite and the disease it produces. It is awkward to say "this disease is *rust*, and it is produced by a *rust*." An improvement upon this would be to state that this disease is uredinosis, and is produced by a rust, giving the botanical name of the rust or even the genus when possible.

(3) The diseases need to have, for popular use, English or at least Anglicised names, and these may well be derived from those already in use.

(4) Names should be as far as possible descriptive, and indicate the plant attacked; therefore more than one word will usually be required, as "peach leaf-curl," the last two words being hyphened. There will be many cases where the name of the host can be coupled with the genus of the parasite, thus giving a substantial compound name, as potato-macrosporium or bean-colletotrichum.

(5) After the pathology of plant diseases is understood much better than now a scientific classification of them can be made, and appropriate names given to each; at present only an artificial system can be hoped for.

A tentative classification and nomenclature may be made in various ways, as, e. g.:

(*a*) from the group names of the parasites as the

Uredineæ producing uredinosis
Bacteria " bacteriosis
Ustilagineæ " ustilaginosis

(*b*) from the gross effect upon the host as rot, scab, spot, blight, rust, smut, club-root, black-knot, mold, gall, damping off, etc., for which Latinized names might be constructed, and

(*c*) from the general cause of the disease; (1) unfavorable habitat, (2) unfavorable atmospheric conditions, (3) mechanical injuries. (4) parasitism, (5) teratogeny.

(6) From what has been presented above it is clear that the results obtained by the Committee are far from final and therefore it is suggested that the work be continued and that it be along the following among other lines:

(*a*) Collate and tabulate the common names of plant diseases now in use.

(*b*) Construct a working scheme in which every plant disease is assigned a place with a distinctive (scientific) name followed by an English name, the last to be, when possible, the one already in use.

(*c*) It is recommended that the parasite should be distinguished from the disease in all cases.

(*d*) It goes without saying that mycologists are urged to apply names to plant diseases instead of leaving the matter of a choice to a popular verdict.

BYRON D. HALSTED,
B. T. GALLOWAY,
GEO. F. ATKINSON,
CHARLES E. BESSEY,
for the Committee.

At the suggestion of the Council, the section appointed special committee to make arrangements for the next meeting, 1895. The committee consists of the vice-president and secretary elect and the sectional committee of the 1894 meeting.

The nominating committee selected for vice-president 1895, Dr. J. C. Arthur, Prof. of Botany, Purdue University, Lafayette, Ind., and for secretary, Mr. B. T. Galloway, Chief of the Division of Vegetable Pathology, Washington, D. C. They were elected in general session, Tuesday.

Papers read before section G, A. A. A. S., Brooklyn meeting, 1894.

GALLOWAY, B. T.: *The growth of radishes as affected by the size and weight of the seed.*—The relation of the weight of the seed to the weight of the products was considered, and the physiological questions involved discussed. It was shown that by using large seed about 90 per cent. of the crop reaches marketable size at the same time. Where mixed seed are used, or seed as it usually comes from the market, from 45 to 50 per cent. only of the crop matures at the same time. In other words, by using large seed 90 per cent. of the crop will mature in from thirty-five to forty days, and where large and small seed are used about 50 per cent. of the crop will mature in the same time.

GOLDEN, KATHERINE E.: *Movement of gases in rhizomes.*—Rhizomes are usually transversely geotropic organs, having stored in them elaborated food. Their epidermis is free from stomata and lenticels, so that the gas found in them can enter through the epidermis only, the tissue absorbing it from the surrounding air. The rhizomes used in the experiments were those of Mentha piperita, Helianthus grosse-serratus, Solanum tuberosum, and Mimulus moschatus, the epidermis of all being unlignified and unsuberized, the outer wall thickened and the cells packed so closely together as to form an imperforate membrane. The inner tissue was made up nearly entirely of parenchyma, having large intercellular spaces through which gases, after gaining access to the interior, could very readily permeate.

1. In the majority of rhizomes examined the contained gases were under greater pressure than the atmosphere, an interval of twenty to twenty-five minutes being required for the pressure of the gases in 1^{mm} of the rhizomes to become the same as the pressure of the atmosphere. The method of procedure was to space off rhizomes into definite lengths, the rhizomes being then placed under water and cut at varying intervals of time, the bubbles of gas, as they rose through the water, being easily seen. The next point determined was the rate of passage of gases through definite lengths of rhizomes that were fastened in tubes filled with mercury. The

descent of the mercury in the tubes showed the rapidity of the passage of the gas. Gas passed through rhizomes very rapidly for the first hour, though becoming slower towards the end of the hour, and finally, as the rhizomes became saturated with the gas, becoming so slow as to take some times a day for the mercury in the tube to come to the level of that outside. The gas passed more rapidly through short than long lengths of rhizomes.

2. To determine passage of gas through sections of epidermis under pressure, sections of epidermis were fastened on the end of a glass tube, which was then filled with mercury and placed in a vertical position in a vessel of mercury. The mercury remained at its original height for days, though the sections would become concave from the pressure on them.

3. To determine amount of diffusion of gases without pressure through living plant membranes and dead plant and animal membranes, sections of hog's bladder and living and dead epidermis were fastened on tubes as before, the tubes being filled with water instead of mercury, the water then being displaced by the gas. The sections permitted considerable diffusion to take place, though the greater amount was attained by the living plant membrane.

4. To determine rate and amount of diffusion of gases through both epidermis and internal air cavities, lengths of rhizomes were fastened air-tight into tubes, the end of the rhizomes extending into the tube being sealed. The tubes were then filled with gas as before, carbon dioxide, hydrogen, and ammonia being used. The ammonia killed the plants so that no comparison between it and the other gases could be made. The carbon dioxide showed greater rapidity and amount of diffusion, and was uniform in diffusing, whereas the hydrogen was subject to fluctuations, the mercury in the tube sometimes dropping to the level of that outside. Both gases diffused more rapidly when the temperature was low, the high temperature very probably causing the gas to exert sufficient pressure to hinder diffusion. The individual plant was the factor of greatest importance, as like plants under similar conditions showed variations in the rate and amount of diffusion.

BEAL, WM. J.: *The sugar maples of Central Michigan.*— Descriptions of A. barbatum and the var. nigrum were given. It was shown that *A. saccharum barbatum* Trelease is not

even a variety, as it is found growing on the tops of numerous trees of the species. A summary of comparisons of *A. barbatum* and *A. barbatum nigrum* was given. It was shown that color of branches and stems, shape of top, number of leaf lobes, depth of sinus, leaf-texture, could none of them be used as diagnostic characters. Intermediate forms between the species and variety were also noted and the author inclined to the conclusion that the varietal rank of A. barbatum nigrum is reasonably established.

COULTER, JOHN M.: *Some affinities among Cactaceæ.*—A study of our species of *Cactus* (Mamillaria), *Anhalonium*, and *Lophophora* has suggested certain lines of genetic affinity, indicated by the relative position and structure of the tubercles, spines and flowers. In the discussion the two subgenera of Cactus (Eumamillaria and Coryphantha) were considered separately. Eumamillaria is characterized by its grooveless tubercle, which bears at its summit the spine-bearing areola, and in its axil the flower-bearing areola. Coryphantha shows the same relative position of the two areolæ but they are connected by a deep woolly groove running down the upper face of the tubercle; in fact, the two areolæ seem to be but expansions of the groove at its extremities. In *Echinocactus* the two areolæ become contiguous at the summit of the tubercle. The relation between Echinocactus and Coryphantha is made evident by intermediate forms, in which the groove gradually shortens, making the flower areola more and more extra-axillary, so that it gradually ascends the tubercle, until reaching its summit and becoming contiguous with the spiniferous areola, the resulting form is an Echinocactus. Whether the groove has gradually shortened or lengthened is not clear, but the indications are that the Echinocactus condition has given rise to Coryphantha, and that, in turn, by the closing of the groove, to Eumamillaria. Related to these forms are two aberrant genera, now regarded as such, but frequently variously referred to Cactus (Mamillaria) and Echinocactus, viz: Anhalonium and Lophophora. The real affinities of these two genera are indicated upon an examination of their growth. The very young tubercles of Anhalonium are those of Coryphantha, such as those of Cactus macromeris, with the floriferous areola extra-axillary, the woolly groove extending about half way down the tubercle. In later development, however, the upper and lower portions of the tubercle be-

come much modified and very different from each other, the upper portion becoming a very thick triangular bract, in some cases preserving the woolly groove, in other cases the groove being obliterated and appearing only as a minute tuft at the tip. In all cases the spiniferous areola is completely obliterated. It seems evident that Anhalonium is an offshoot from forms intermediate between Echinocactus and Coryphantha.

Lophophora has been still more puzzling, as it shows a grooveless tubercle, upon the summit of which is the floriferous areola, suggesting at once Echinocactus, to which the forms have mostly been referred. However, the entire disappearance of a spiniferous areola should suggest doubt. The very young tubercle of Lophophora shows the floriferous areola below the summit, but the small tip develops no further, while the floriferous areola becomes terminal by the large development of the lower portion of the tubercle into a broad mass, in the center of which the floriferous areola appears as a small depression with a penicellate tuft of hairs.

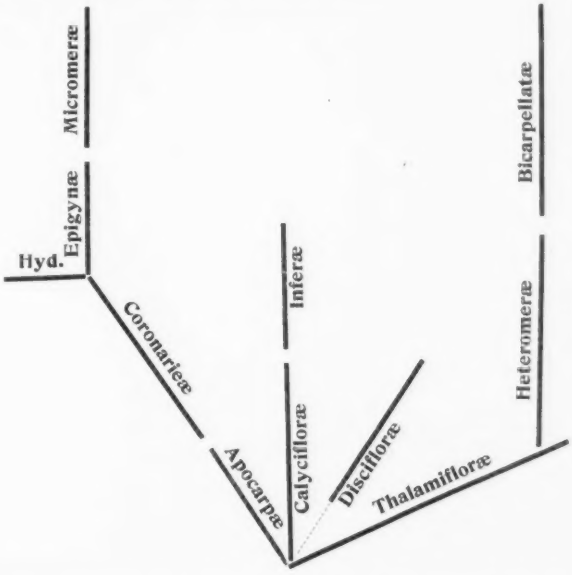
In conclusion, in the group of forms under consideration, Echinocactus is suggested as the primitive one, with its grooveless tubercles bearing at summit the contiguous areolæ. The formation of a groove separating these slightly at first, and finally carrying the floriferous areola to the axil of the tubercle, has given rise to Coryphantha, intermediate forms having given rise to the aberrant genera Anhalonium and Lophophora; while the closing of the Coryphantha groove has given rise to Eumamillaria. It may be that this evolution has proceeded in the opposite direction, from Eumamillaria to Echinocactus, but it would not change the relative position of the genera here suggested.

BESSEY, CHARLES E.: *Simplification and degeneration of structure in the angiosperms.*—The speaker emphasized the thought that evolution proceeds in the direction of increasing simplification as well as of increasing complexity. The Umbelliferæ and Compositæ were used as illustrations of groups of high rank in which there has been a simplification of the floral parts. This is not to be confused with real degeneration, such as occurs in dodder and mistleto.

NEWCOMBE, F. C.: *Regulatory growth of mechanical tissue.*—To be published in full in this journal.

BESSEY, C. E.: *Further studies in the relationship and arrangement of the families of flowering plants.*—The paper

presented a brief discussion of the primitive flower of the monocotyledons; modifications of the primitive flower by increased complexity of structure; the origin of sedges and grasses; development of irises and orchids; the primitive flower of the dicotyledons; modifications by increased complexity; modifications by simplification; development of the Bicarpellatæ and of the Inferæ. It was accompanied by the following chart of suggested changes in the arrangement of groups in accordance with genetic lines.



SMITH, ERWIN F.: *The watermelon disease of the South.* —This is a disease of the vine of hitherto unknown origin, widely prevalent in the melon districts of the southeastern United States and so destructive that growers in Georgia believe that it is impossible to raise melons in the same field two years in succession, or oftener, with profit, than once in 5 to 7 years. In some districts in Georgia and South Carolina the disease has this year reduced shipments one-third to one-half, and in the worst cases has taken the whole crop of individual growers.

Large vines in full vigor wilt suddenly, without apparent cause. This is followed in a few days by the death of the vine, but during this period there are no external indications of parasites, either above ground or below. The cortex is turgid, free from spotting, and normal in color at the time the leaves begin to wilt.

Constantly associated with the earliest stage is a fungus apparently undescribed and to which I have given the provisional name, *Fusarium niveum.* It occurs in the ducts of the stem, filling them more or less completely and interfering with the movement of water from roots to foliage. The fungus was most abundant near the crown, but it was found in many parts of the root system and in the vessels of the stem abundantly as far as 0.5–1.5^{m} away from the roots.

This fungus gains entrance through the root system, and there are some indications that this infection takes place principally within the first few weeks after planting. At that time all the tissues are attacked, in hot wet weather damping off the seedlings as energetically as a Pythium. Later the parenchyma becomes more resistant, and the fungus betakes itself to the bundles, and especially to the ducts, but when the stem begins to shrivel it is again found invading the parenchyma.

Conidia are produced abundantly within the vessels of the vine and pure cultures have been made from these.

The most badly attacked fields observed in South Carolina were those heavily fertilized with barnyard manure made from what is locally known as "watermelon hay," i. e., wild grass, cut in autumn from melon fields, including many blighted vines. This is composted and put back on the fields at time of planting. In my judgment a modification of the method of manuring, a judicious rotation of crops, and the prompt destruction of diseased vines would do much to lessen the prevalence of this disease.

ATKINSON, GEO. F.: *Preliminary note on the relation between the sterile and fertile leaves of Onoclea.*—The complete differentiation between the fertile and sterile leaves of *Onoclea sensibilis* suggested that the so-called var. *obtusilobata,* which is an intermediate state, could be artificially induced by amputating the early vegetative leaves of this fern. The leaves were then cut from a patch of this fern on May 11th, June 9th, and July 12th, respectively. On July 12th, a few leaves

were seen which showed the transition stages. On August 8th and 9th the plants were gathered and every conceivable gradation between the fertile and sterile leaves was present, as illustrated in over thirty specimens. Some leaves of the fertile kind were expanded to a size equal to that of large sterile leaves, but usually the venation was coarser and a few rudimentary indusia could usually be found on the basal pinnules of the lower pinnæ. Some leaves were found which it was impossible to properly correlate. The number and perfection of the sporangia as well as the indusia varied in accordance with the variation of the leaves. On those leaves or parts of leaves where but few or rudimentary sporangia were developed, there were frequently cases of apospory, rudimentary prothallia being developed from the placental region.

RUSBY, H. H.: *Lophopappus, a new genus of mutisiaceous Compositæ, and Fluckigeria, a new genus of Gesneriaceæ.*—The author gave the general characters of the groups to which the new genera belong, their positions in such groups, the occurrence of the plants on which the new genera are based, and the description of the latter.

ATKINSON, GEO. F: *Preliminary note on the swarm spores of Pythium and Ceratiomyxa.*—Recent study of the "damping off" fungus from fern prothallia and green house cuttings of dicotyledons has served to show that considerable confusion exists concerning our knowledge of the swarm spores of the genus *Pythium*, or that the genus is a very heterogeneous one. In DeBary's[1] earlier work he says that *P. proliferum* possesses oval uniciliate zoospores, and that occasionally double zoospores made their escape before they were completely formed. These possessed two cilia and later divided into uniciliate zoospores. *P. reptans*[2] on the other hand has biciliate zoospores, which are reniform, and the cilia on one side not far from the end. Without division these rounded off and germinated. In the later work[3] he places *Pythium* in the Peronosporaceæ and says the members of the family possess swarm spores with twolateral cilia. Schrœter[4] characterises the swarm spores of his family Pythiaceæ as being reniform

[1]Einige neue Saprolegnieen. Prings. Jahrb. f. wiss. Bot. **2:** 185. 1860.
[2]Ibid. p. 187–8.
[3]Beitr. z. Morph. u. Phys d. Pilze **4:** 93. 1881.
[4]Engler u. Prantl's Natürlich. Pflanzenfam. **1:** —. —.

with two lateral cilia, and yet introduces Hesse's figure of *P. DeBaryanum* with oval uniciliate zoospores.

According to Pringsheim,[5] *P. entophytum* has uniciliate zoospores. *P. cystosiphon* Lindstedt *(Cystosiphon pythioides* R. & C.), according to Roze and Cornu[6], has reniform swarm spores, the two cilia arising from the pointed ends instead of from the side. *P. Equiseti* Sadebeck,[7] which DeBary[8] places as a synonym of *P. DeBaryanum*, has swarm spores exactly like those of *P. cystosiphon*. *P. DeBaryanum* Hesse, as indicated above, has, according to its author, oval uniciliate swarm spores.

The Pythium which I have studied from the botanical conservatories of Cornell University is what I have supposed to be the *P. DeBaryanum* Hesse, and is probably what usually passes for that fungus in America. The peculiarities which I have observed are as follows: The swarm spores in process of formation are reniform with rounded ends, the developing cilia issuing from the broadly rounded ends, which because of the form of the body are turned to one side. On issuing from the swarm-sporangium they are long reniform with pointed ends and a cilium is attached to each end directly at the point. After swarming for a while amœboid movements ensue without the loss of the cilia. Soon a constriction appears and eventually the swarm spore divides into two oval uniciliate swarm spores. These swarm again and eventually come to rest and germinate. The questions arise whether these discrepancies are due to imperfect observations on the part of some, or whether there are specific differences according to the character of the zoospores, or whether all are at first biciliate, becoming later uniciliate, or whether there is great variation in the different species in this respect, so that at one time both kinds of zoospores will be developed and at another time only one kind. These questions I shall not attempt at this time to answer.

In studying the germination of the spores of a species of *Ceratiomyxa* Schrœter[9] *(Ceratium* A. et S.), a form was used

[5] Prings. Jahrb. f. wiss. Bot. **1**: 289. 1859.

[6] Sur deux nouveaux types génériques pour les familles des Saprolégniées et des Péronosporées. Ann. d. Sci. Nat. Bot. V. **11**: 78. 1869.

[7] Unters ü. Pythium Equiseti. Cohn's Beiträge z. Biologie d. Pflanzen **1**: 121. 1875.

[8] Zur Kenntniss der Peronosporeen. Bot. Zeit. **39**: 528. 1881.

[9] Engler u. Prantl's Natürlich. Pflanzenfam. **1**: 16. —.

which may be the type of a new species to be known as *C. plumosa*. The sporophores possess a stout base but are very profusely and finely branched, very much more so than *C. mucida* (P.) Schrœt., and have been chiefly found on rotting elm and basswood stumps or logs. Spores freshly matured and sown in pure water before drying germinated within two to six hours.

The germination differs from that of any other genus of the Myxomycetes. Through a small perforation in the wall of the spore the protoplasm escapes slowly as a vermiform body which possesses tortuous motions and slight amœboid movement of the surface. In the course of fifteen minutes to one hour this shortens and becomes amœbiform, the developing pseudopodia being quite short and slender but longer than those on the vermiform body. Four rather clear spaces appear in the protoplasm which precede the simultaneous parti-division of the mass into a four-lobed body. These then farther divide once forming an eight-lobed body; minute pseudopodia developing the meantime over the surface of all the lobes. A single long cilium is now developed from the end of each lobe and quite violent lashings follow accompanied by the continued development of the pseudopodia.

The individual lobes separate frequently in pairs which remain for a time in communication but eventually separate. Sometimes three to six may remain joined for several hours assuming various shapes, but always showing the individual lobes and the long cilium. These frequently simulate the form of a star fish.

Famintzin and Woronin[10] have studied the germination of the spores of *Ceratiomyxa mucida* (P.) Schrœt. *(Ceratium hydnoides* A. & S.) and their account differs somewhat from that which I have observed. In the first place they were not able to germinate the spores until after they had passed a period of drying, and then only in a nutrient medium formed by a solution of rotten pine wood in water. They were not able to induce germination in water alone. The spores germinated only after about thirty hours from the time of sowing. On germination there was no vermiform body but the amœboid form issued directly, and division began by bi-parti-division instead of quadro-parti-division and continued up to the eight-lobed body when they separated in pairs.

[10]Ueber zwei neue formen von Schleimpilzen: Ceratium hydnoides A. et S., u. C. porioides A. et S. Mém. d. l' Acad. Imp. d. Sci. d. St. Petersbourg, **20:** —. 1873. [No. 3.]

It is difficult to believe that specific differences would account for the differences in the observations, nor can we suppose that Famintzin and Woronin overlooked the vermiform body in the first stage of germination. Probably there may be some variation in individuals in this respect.

BRITTON, ELIZABETH G.: *A revision of the genus Scouleria.*—The author described the type of the genus, *Scouleria aquatica*, and reduced *S. Nevii* Kindb. and *S. Muelleri* Kindb. to it. *S. marginata* was described as a new species. The paper was illustrated by drawings and specimens.

WILDER, BURT G.: *Evidence as to the former existence of large trees on Nantucket Island.*—Fragments of large trees have been found while cutting peat at Polpis, Hughes' Neck, and the author saw in this bog a stump 1.75^{m} in circumference. Near by as many as twenty stumps of various sizes were found.

BRITTON, N. L.: *Notes on the primary foliage and leaf-scars in Pinus rigida.*—The author exhibited twigs and old bark of this pine and discussed the foliar morphology, suggesting the possible affinity of some fossil plants commonly grouped with pteridophytes with the pines. The resemblance between the primary leaf-scars and those on the stems of lepidodendrids is certainly striking.

HALSTED, BYRON D.: *Notes on Chalara paradoxa.*—The fungus *Chalara paradoxa* (De Seynes) Sacc. is recorded in Saccardo's Sylloge Fungorum. The writer studied it during the present year as growing upon pineapples. It furnishes the best material thus far met with for illustrating the internal abjunction of spores. When the time arrives for the production of these spores, the tip of the hypha dissolves and the protoplasmic contents become divided serially into a row of hyaline cylindrical spores which are pushed out of the tip of the spore-bearing hypha. While the process of spore formation is at its height the time for the deliverance of a spore may not exceed fifteen minutes.

There is a second form of spore much larger than those above described, that forms in the ordinary way and, not separating readily, produces long necklace chains. There is a third form of spore midway between the two sorts mentioned in that it is produced by internal abjunction but is brown and oval and not hyaline. This is likely a variation due to conditions under which the spores are produced. There are

also spores produced within the substance of the host (pine-apple flesh) that are still different.

BRITTON, ELIZABETH G.: *A hybrid among the mosses.*—Definite record of hybrids among some species of mosses have been made in Europe. The author here makes the first American record of such a hybrid. The parents are *Aphanorhegma serrata* ♀ × *Physcomitrium turbinatum* ♂ (?). The specimens were distributed as *Schistidium serratum* in Drummond's Southern Mosses no. 20. They show both the normal fruit of one of the parents and the hybrid capsules, growing together from the same stem.

HALSTED, BYRON D.: *Notes upon a root-rot of beet.*—During the present year a serious fungous decay was found upon the roots of field and garden beets. It seems to be an undescribed species of the genus Phyllosticta. The present paper describes the rapid and profuse development of the pycnidia of this fungus upon the cut surface of the affected parts of the beets; the complete separation of the pycnidia by the intervention of a layer of thin cloth laid upon the freshly cut surface; and the confirmation of previous statements regarding the non-sexual origin of the pycnidia.

BRITTON, N. L.: *On Torreya as a generic name.*—As an evidence that the law of homonyms is necessary for stability of nomenclature, the case of Torreya was presented, a generic name which has been applied six times. The record is as follows:

Torreya Raf. (1818) = *Synandra* Nutt. (1818).
Torreya Raf. (1819) = *Pycreus* Beauv. (1807).
Torreya Spreng. (1821) = *Ægiphila* Jacq. (1774).
Torreya Eaton (1833) = *Mentzelia* L. (1753).
Torreya Arnott (1838) = *Tumion* Raf. (1840).
Torreya Croom (1843) = *Croomia* Torr. (1840).

The only one of these genera that has stood has been the Florida taxoid tree of Arnott.

BRITTON, ELIZABETH G.: *Some notes on the genus Encalypta.*—The author compared the European and American specimens of *E. ciliata*, with some notes on *E. longipes* and *E. Macounii*.

HOTCHKISS, JED.: *The growth of forest trees illustrated from marked corners 107 years old.*—Specimens illustrating marks on corner and line trees taken from the Henry Banks

10,980 acre patent, in Greenbrier co., W. Va., surveyed April 18, 1787, were shown. The growth varied from .03 to .05^{in} per year, and the number of growth layers agreed in number exactly with the record.

PATTERSON, MRS. F. W.: *Species of Taphrina parasitic on Populus.*—American mycologists formerly referred to *Taphrina aurea* specimens occurring on ovaries of *Populus tremuloides* and other hosts. It has been shown, however, that the name T. aurea belongs only to the form on leaves, which has not been known heretofore in America. The form on ovaries was then supposed to be identical with Johanson's *T. rhizophora* but from this it now proves to be quite distinct and easily recognized by size of asci as belonging to *T. Johansonii* Sadebeck. A form differing but slightly from T. aurea has now been found also in Iowa, parasitic of several species of Populus planted from Europe.

The following papers were presented in joint sessions of Sections F and G:

BUTLER, A. W.: *Work of the Indiana biological survey.*—An account of the organization of this work by the Indiana Academy of Sciences, its plan and progress.

HOPKINS, A. D.: *Some interesting conditions in wood resulting from the attacks of insects and woodpeckers.*—The author described the modes of attack by which wounds involving twisted grain and various discolorations were brought about. It was stated that the curly or "bird's-eye" grain of poplar was due to the persistent wounds made by the downy woodpecker, and the same cause was suggested for the bird's-eye maple. Further investigations are in progress.

BAILEY, L. H.: *Relation of age of type to variability.*—1. There is a wide difference in variability in cultivated plants. Some species vary enormously. The type of lettuce, cultivated for somewhat less than 2,000 years, was early lost and the cultivated species was named *Lactuca sativa* but it is really the *L. Scariola.* The type of soja bean and of the sweet potato are not known. Of tomatoes the cultivated varieties are more removed from the type than many species are from each other.

2. Variability is not due to age, cultivation, nor geographical distribution.

3. Variability under cultivation is due to some elasticity of the species and is thus inherent.

4. The newer the type the more readily it varies. New types are polymorphous, old types are monomorphous. The most flexible types have not yet passed their zenith, e. g., Cucurbitaceæ. The varieties of cereals are so much alike that expert knowledge is needed to distinguish them.

5. Why are new types flexible? A certain answer cannot be given but the author believes it explicable on the principle of divergence of characters rather than by any rejuvenescence of type.

BAILEY, L. H.: *The struggle for existence under cultivation.*—The struggle for existence under cultivation can be resolved into figures. Seedsmen estimate that one-fourth the seed produced is lost because unsown. (But this is less than nature wastes among wild plants.) Three-fourths therefore engage in the struggle for existence. Only one in thirty or one in twenty of these come to anything. The rest are thinned out. This is a struggle between members of the same species; therefore the struggle sets up a divergence within the species. Added to this is the selective agency of the weeder. The same laws which govern evolution in feral conditions govern evolution under cultivation.

MILES, MANLY: *Limits of biological experiments.*—The author contended that evolutionary laws cannot be demonstrated by direct experiment because of the great number of uncontrollable factors, a point well illustrated by the many valueless feeding experiments.

Titles of informal papers and notes presented before the Botanical Club, A. A. A. S., Brooklyn meeting, 1894.

C. E. BESSEY: *The germination of the macrospores of Marsilia vestita.*

E. F. SMITH: *Tannin as a mordant for staining cell-membranes.*

F. C. NEWCOMBE: *Tannin as a mordant for staining protoplasmic structures.*

W. J. BEAL: *The use of measurements in the identification of grasses.*

L. R. JONES: *The decrease of oat-smut in Vermont.*

B. T. GALLOWAY, E. F. SMITH and G. H. HICKS: *Formaline as a preserving fluid.*

N. L. BRITTON: *The check-list of plants of the northeastern states.*

E. F. SMITH: *The bacterial disease of cucumbers with an exhibit of photomicrographs.*

C. E. BESSEY: *Extreme decapitalization.*

L. R. JONES: *A Haematococcus for class-demonstration of motile gametes.*

E. J. DURAND: *Sporangial trichomes on certain ferns.*

ARTHUR HOLLICK: *The significance of stipules from the standpoint of paleobotany.*

C. R. BARNES: *The finding of a considerable quantity of Eustichia Norvegica in Wisconsin, in fruiting stages.*

J. J. DAVIS: *Gonidial chains of Entyloma flœrkeæ.*

B. D. HALSTED: *Solandi printing of variegated leaves.*

C. E. BESSEY: *A better pronunciation of botanical terms.*

B. D. HALSTED: *The peach-spotting fungus as a leaf parasite.*

E. J. DURAND: *Development of Olpidium sp., one of the Chytridiaceæ.*

B. D. HALSTED: *A peculiar discoloration of the Paeonia leaf.*

E. F. SMITH: *A simple method of making pure cultures of fungi.*

C. E. BESSEY and ROSCOE POUND: *The work of the Botanical Seminar of Nebraska.*

M. B. WAITE: *The killing of young shoots of the pear by excessive transpiration.*

M. B. WAITE: *Staining the flagella of bacteria.*

BRIEFER ARTICLES.

Pleodorina in Indiana.—On the eleventh of last May the writer collected specimens of *Callitriche heterophylla* Pursh, and *Nitella* sp.? from a shallow, stagnant pond near Bloomington, Ind. A small quantity of this material was kept fresh in a bell-jar in a north window of the laboratory. On June 29th, while searching for unicellular algæ for the use of my class, I noticed numbers of little, pale green specks along the wall of the glass vessel below the surface of the water. They were at once taken to be Volvox. A microscopic examination convinced me, however, that these plants differed from any Volvox that I had ever seen.

Having no special literature on the Volvocineæ, I did not feel certain as to the precise limits of the genus Volvox.

However, a study of the life history was begun immediately as, in the specimens in question, the asexual development from the gonidia could be very readily followed.

While in the midst of my investigations, the BOTANICAL GAZETTE for July, to my agreeable surprise, brought me the paper of Mr. W. R. Shaw of Stanford University on "Pleodorina, a new genus of the Volvocineæ."

A glance at this paper convinced me that the organism at hand was *Pleodorina Californica* Shaw, and a closer comparison confirmed the opinion. Almost every detail in the study made by me agreed with those presented in Mr. Shaw's paper.

Together with few minor details which may be of little importance, some of the specimens examined by me, however, were a little larger than the measurements given in the paper. The plant body of the largest individuals observed, measured 352μ in diameter, the gonidia just previous to the first division, 24–32μ; vegetative cells, just one-half of the gonidia in the same colony, 12–16μ.

Up to July 27th the plants, then numbering thousands in the same bell-jar, were in good condition, multiplying rapidly.

It is to be hoped that the sexual reproduction, if possessed by this plant, may occur and be observed this fall.—DAVID M. MOTTIER, *Indiana University, Bloomington.*

Pleodorina in Illinois.—The new alga *Pleodorina Californica* described in the July GAZETTE was found during the month of June in abundance at Havana, Ill.. by Prof. T. J. Burrill and myself. This is where the University of Illinois has its new Experiment Station for

the study of aquatic life, and is a rich collecting ground for algæ.—G. P. CLINTON, *Champaign, Ill.*

Fruiting Eustichia Norvegica Brid. — This rare moss has been known in the vegetative condition for many years. It occurs in different parts of the world, and has been found in half a dozen or more localities in this country. In the fruiting condition, however, it is little known. Mrs. E. G. Britton discovered it in fruit at the dells of the Wisconsin river, near Kilbourn City, Wisconsin, in July, 1883, and described the fruit in the *Bulletin* of the Torrey Botanical Club 10: 99. 1883. Seventeen fruiting specimens were found. These, up to the present summer, were all that were known to exist. The herbarium of the University of Wisconsin is now, however, in possession of a sufficient quantity in fruiting condition to distribute to all bryologists desiring it.[1]

While working on a botanical survey of the Wisconsin river valley, Mr. F. D. Heald and I collected between eight and nine hundred fruiting specimens in "Witches' Gulch," near Kilbourn City, Wisconsin, in the latter part of July of the present year.

Among the capsules are many one year old at least, while it is quite possible that some of them are older. This would indicate that the difficulty experienced in finding fruiting material is due chiefly to rarity of fructification and not to the disappearance of fruiting parts soon after maturity. The capsules probably matured in July. Part of the material collected by Mrs. Britton in the early part of July is immature. The capsules collected this summer are, with scarcely an exception, mature, many of them having already dehisced. An examination of the capsules shows the entire absence of peristome and annulus.—L. S. CHENEY, *University of Wisconsin.*

[1] Applications for specimens must be accompanied by postage (unless from foreign countries) and should be addressed to the Department of Botany, University of Wisconsin, Madison, Wis., U. S. A.

CURRENT LITERATURE.

The flora of Mt. Desert.

THE FLORA of Mount Desert has for some years been the object of careful study, and the result has now appeared in a very handsome volume.[2] An outline of the geology of the island is furnished by Professor W. M. Davis of Harvard. The summary shows 751 phanerogams, 47 pteridophytes, 271 bryophytes, and 421 thallophytes excluding funi and myxomycetes, which have not been collected. A carefully prepared introduction gives a general description of Mt. Desert and its flora. Some of the noteworthy features are the arctic character of the flora, the very small representation of introduced foreign plants, the scanty showing of Leguminosæ, the entire absence of Asclepias, Gentiana, and other well known genera, and the remarkable beauty and deepness of coloration.

The introduction also contains a somewhat extended discussion of nomenclature, brought on by the recent attempts of American botanists towards stability. In the list the nomenclature of the last edition of Gray's Manual is followed, a principle which the GAZETTE has always strongly advocated for local lists. In the discussion of what is known as the "Rochester Code," however, the argument is weakened by the frequent imputation of unscientific motives to those concerned in framing the code. We believe in difference of opinion and a strong expression of it, in fact there was an abundance of this among those who by mutual concession framed the code, but we do not see that any position is strengthened by calling those who oppose it names. We could wish that the strictures, which are good enough in their way, had been pruned of the gratuitous assumption of motives which we know do not exist. When the botanists who were at Rochester learn that "less than one day was sufficient for this committee" (on nomenclature) they will be somewhat surprised, for they were not aware that any point was considered that had not been under discussion for years. The mistakes made were certainly only those of judgment and not of intention. Of course there was no thought that the code would be binding except upon those who chose to follow it, but it was believed that the best interests of American botany would be subserved by coming to some agreement concerning nomenclature.

[2] RAND, EDWARD L. and REDFIELD, JOHN H.—A preliminary catalogue of the plants growing on Mt. Desert and the adjacent islands. With a map. 8vo. pp. 286. Cambridge: University Press. 1894.

Minor Notices.

ANOTHER practical botany[1] has been added to the list of laboratory guides, this time for beginners. Professor Bower has really given us an abridgement of his "Course of Practical Instruction in Botany," so that its spirit and method is familiar. The book can be of excellent service in our secondary schools, and even in the elementary courses of most colleges, provided, always, that it is in the hands of a competent teacher, and this any book demands. The information as to methods of preparation, and the introductory exercises on the structure of the vegetable cell, and the common micro-chemical reactions, are very helpful to the inexperienced teacher. As is known, the author begins with the highest types, an order of treatment which we do not consider scientific or necessary. There is no reason why the mucor of the last study should be any more difficult for a beginner to see and to understand than the tissues and ovule structures of the first types. The excellence of the work demanded, however, and the scientific spirit of it all, needs no comment.

THE PROCEEDINGS of the Madison Botanical Congress have recently been published by Secretary J. C. Arthur. The issue was much delayed by the dilatoriness of speakers and committeemen in revising manuscript and proof sheets. The report makes a handsomely printed pamphlet of sixty pages with an index by which all references to the matters discussed can easily be found. Copies may be obtained by application to Dr. J. C. Arthur, Lafayette, Indiana.

IN CONNECTION with the study of some recent collections, Mr. F. H. Knowlton[2] has given a review of the fossil flora of Alaska. An historical review, list of species, and discussion of beds are given. Of the 115 forms enumerated forty-six are peculiar to Alaska. The same author has published in *The Journal of Geology* (May–June, 1894) an instructive paper on "Fossil plants as an aid to geology."

A RECENT contribution[3] from the Gray Herbarium contains descriptions of some twenty-five new Mexican plants, among them the beautiful new pine (P. Lumholtzii) with dense pendulous foliage recently figured in *Scribner's Magazine.*

---

[1] BOWER, F. O.—Practical botany for beginners. pp. xi. 275. Macmillan & Co., London and New York, 1894. 90 cents.

[2] KNOWLTON, F. H.—A review of the fossil flora of Alaska, with descriptions of new species. Proc. U. S. Nat. Mus. **17:** 207–240. *pl. 1.* 1894.

[3] ROBINSON, B. L. and FERNALD, M. L.—New plants collected by Messrs. C. V. Hartman and C. E. Lloyd upon an archæological expedition to northwestern Mexico under the direction of Dr. Carl Lumholtz. Proc. Am. Acad. **30:** 114–123. Aug. 27. 1894.

OPEN LETTERS.

Added synonymy.

In noticing the revision of the N. Am. Alsineæ by Dr. B. L. Robinson, in the August number of the GAZETTE, was it *fair* to say that in using the name Spergularia, he has "added to the synonymy of this much vexed group"? Certainly *he* did not add that name to the synonymy, for it is the one which has been in most general use since the time of Presl, and until botanists can settle the relative precedence of the resurrected names Tissa and Buda, those who follow the general usage of half a century can hardly be the ones who "disturb our peace"!—JOHN H. REDFIELD, *Philadelphia, Pa.*

[Naturally no reference was made to the addition of Spergularia to synonymy, but to the consequent addition of new binomial combinations.—EDS.]

Marchantia as a type.

Dr. Underwood's objection to the use of Marchantia as a type in morphological courses of study expressed in several places recently and reiterated in his vice-presidential address at Brooklyn last month seems to me based upon a misunderstanding. I use this plant constantly in my classes, but not, as Dr. Underwood seems to imply it must be used, as a type of the heterogeneous Hepaticæ. Certainly no teacher at all familiar with morphology could make so evident a mistake as to do that. I use it, and I think others also use it, as a type of the very development which Professor Underwood in his admirable address used it to illustrate, viz., the greatest possible complexity of the *thallus*. For neither of the other two lines of development, of a leafy axis or of the sporogone, do I take types from the Hepaticæ. The possibilities in both these directions I find far better illustrated in one of the true mosses, such as a Bryum or a Brachythecium. Were I writing a laboratory handbook for a course in morphology, such as Arthur, Barnes, and Coulter's *Plant Dissection*, or Bower's *Practical Botany*, I am inclined to think I should include the time-honored Marchantia as one of the bryophyte types, in spite of the fact that it is a representative of only a small group of hepatics and that the lowest.—R.

NOTES AND NEWS.

A FINE illustration of Cereus Pecten-aboriginum appears in *Garden and Forest* of August 22d.

THE "Systematic Botany of North America" is rapidly assuming definite shape. Sample pages have been distributed, subscriptions are being received, and certain parts are announced for 1895. Additional work has been begun by numerous botanists, and there is every prospect that this great undertaking will advance steadily to its completion.

IN *Le Botaniste* for July the six papers are all by the editor, M. P.-A. Dangeard, the subjects being: Observations on the green bacteria, Researches in the structure and sexual reproduction of Mucorini, Sexual reproduction of Entyloma Glaucii, Researches in the structure of lichens, Sexual reproduction of Ascomycetes, and Note on an anomalous flower of Tulipa sylvestris.

BY THE BURNING of the Knox Warehouse, in Washington, last month, Prof. F. Lamson-Scribner lost his entire herbarium with the exception of the genus Panicum which he was studying. This was one of the best studied and arranged collections of North American grasses in existence, including many types as well as a number of California species of Dr. Kellogg's collecting, which were in Professor Scribner's hands for study. The loss is quite irreparable, and the GAZETTE begs to extend its sympathy.

THE ORGANIZATION of the Botanical Society of America was completed at Brooklyn, where the charter members were called to meet on August 15th. The report of the committee upon constitution was presented, and after full discussion and amendment was unanimously adopted. This constitution provides that only American botanists engaged in research, who have published work of recognized merit, shall be eligible to active membership. Candidates for active membership must be recommended by three active members of the Society, but any nominee may be objected to by any member and if ten members object the name will not be considered by the Council. Nominees may be rejected by two negative votes in the Council, a body of seven, or by one-fifth the votes cast even after submission by Council.

Officers were elected as follows: president, William Trelease; vice-president, Nathaniel Lord Britton; secretary, Charles Reid Barnes; treasurer, John Donnell Smith; additional members of council, Charles Sprague Sargent, Edward Lee Greene.

No new members were elected, as it was considered best to elect the first members in accordance with the rigid provisions of the constitution.

The first annual meeting will be held in Chicago (if the A. A. A. S. meets in San Francisco) shortly before the meeting of the A. A. A. S.